3.7 Magnetism and Electromagnetism: Test Pack

AQA 8463 · Calculator allowed · about 50 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A student holds two bar magnets close to each other and observes what happens.

(a) Which pair of poles will attract each other when brought close together? **(1)**

- ☐ A) N and N
- ☐ B) S and S
- ☐ C) N and S
- ☐ D) Poles do not attract, they only repel

(b) State where the magnetic field of a bar magnet is strongest. **(1)**

(Total for Question 1 is 2 marks)

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2 A teacher describes a magnetic field around a straight current-carrying wire and draws concentric circles around the wire.

(a) State the shape of the magnetic field around a straight current-carrying wire. **(1)**

(b) Give one simple safety point when demonstrating current in a wire for this experiment. **(1)**

(Total for Question 2 is 2 marks)

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3 Iron filings are sprinkled around a bar magnet and the pattern is observed.

(a) Describe the shape of the magnetic field lines around a bar magnet. **(1)**

(b) State where the magnetic field is strongest around a bar magnet. **(1)**

(c) Explain why the iron filings form lines rather than a uniform cloud. **(1)**

(Total for Question 3 is 3 marks)

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4 A simple demonstration shows a coil of wire near a magnet. When the magnet is moved into the coil, a current is detected for a short time.

(a) Explain why a current is detected when the magnet is moved into the coil but not when the magnet is held still inside the coil. **(4)**

(Total for Question 4 is 4 marks)

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5 A current-carrying loop of wire in a uniform magnetic field experiences a turning effect (a couple). Give any two factors from the list below that increase the size of the turning effect on the loop: number of turns, resistance of the wire, area of the loop, frequency of current, magnetic flux density.

(Total for Question 5 is 2 marks)

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6 A solenoid is a coil of wire that produces a magnetic field when a current flows through it.

(a) Describe the magnetic field pattern produced by a solenoid carrying a current. **(2)**

(b) State two ways of increasing the strength of the magnetic field produced by a solenoid. **(2)**

(c) An electromagnet, rather than a permanent magnet, is used in a scrapyard crane to lift and move scrap metal. Explain why an electromagnet is more useful than a permanent magnet for this purpose. **(2)**

(Total for Question 6 is 6 marks)

7 A simple direct current (d.c.) electric motor consists of a rectangular coil of wire that rotates between the poles of a permanent magnet. The ends of the coil are connected to a split-ring commutator.

(a) Describe the role of the split-ring commutator in the motor. **(2)**

(b) Explain, in terms of forces, why the coil rotates continuously. **(3)**

(Total for Question 7 is 5 marks)

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8 A straight wire runs vertically, from the bottom to the top of the page, and carries a current upwards. The wire lies between the poles of a magnet, positioned so that the magnetic field points horizontally across the page, from left to right.

(a) Using Fleming's left-hand rule, state the direction of the force on the wire (choose from: out of the page, into the page). **(1)**

(b) The current in the wire is reversed, so that it now flows downwards. State and explain the effect this has on the force on the wire. **(2)**

(Total for Question 8 is 3 marks)

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9 A coil has 250 turns. The magnetic flux through each turn changes from 1.2×10^{-4} Wb to 4.2×10^{-4} Wb in 0.20 s. Calculate the average induced emf in the coil using emf = N x (change in flux) / time. State the sign convention if the flux increases.

(Total for Question 9 is 3 marks)

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10 Electrical power is transmitted around the country through the National Grid using overhead cables. Each cable has a resistance of 5.0 ohms. Use the Physics Equations Sheet. Use the equation: power = current^2 x resistance ($P = I^2 R$)

(a) Calculate the power dissipated as heat in the cable when it carries a current of 10 A. **(2)**

(b) The same amount of power could instead be delivered to consumers using a lower transmission voltage, which requires a current of 100 A in the same cable. Calculate the power dissipated as heat in the cable in this case. **(2)**

(c) Using your answers to parts (a) and (b), explain why the National Grid transmits electrical power at a high voltage and a low current, rather than at a low voltage and a high current. **(3)**

(Total for Question 10 is 7 marks)

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Mark scheme · 3.7 Magnetism and Electromagnetism: Test Pack

Question 1

(a) C (unlike poles, N and S, attract) **B1**

(a) Answer: C

(b) at the poles (the ends) of the magnet, oe **B1**

(b) Answer: At the poles (the ends) of the magnet.

Question 2

(a) concentric circles around the wire cao **B1**

(a) Answer: Concentric circles around the wire.

(b) avoid high currents or use low voltage only; do not touch hot wires; switch off before changing connections, oe **B1**

(b) Answer: Use a low voltage/small current and switch off before changing connections.

Question 3

(a) lines curve from north to south around the magnet, forming loop shapes **B1**

(a) Answer: Field lines curve from the north pole to the south pole in loops around the magnet.

(b) near the poles cao **B1**

(b) Answer: Near the poles

(c) filings become tiny induced magnets and align along the field direction, showing the field lines **B1**

(c) Answer: The filings become tiny induced magnets and align along the magnetic field, showing lines rather than a uniform cloud.

Question 4

(a) states that moving the magnet changes the magnetic field through the coil **M1**

(a) links change in magnetic field to induced current (electromagnetic induction) **M1**

(a) states that when the magnet is held still there is no change in magnetic field so no current is induced cao **A1**

(a) gives reason that only a changing magnetic field induces a current, oe **B1**

(a) Answer: Moving the magnet changes the magnetic field through the coil and this change induces a current (electromagnetic induction). When the magnet is held still the magnetic field is not changing so no current is induced.

Question 5

one correct factor: number of turns, or area of the loop, or magnetic flux density **B1**

a second, different correct factor from the same list: number of turns, area of the loop, magnetic flux density **B1**

Answer: Any two of: number of turns, area of the loop, magnetic flux density

Question 6

(a) the field pattern is similar in shape to that of a bar magnet, with a north pole at one end and a south pole at the other, oe **B1**

(a) the field is strong and (approximately) uniform inside the solenoid, oe **B1**

(a) Answer: Similar to the field of a bar magnet (a north pole at one end, a south pole at the other), and strong and uniform inside the coil.

(b) increase the current flowing through the solenoid, oe **B1**

(b) increase the number of turns of wire on the solenoid, or add an iron core, oe **B1**

(b) Answer: Increase the current, and increase the number of turns of wire (or add an iron core).

(c) the magnetic field of an electromagnet can be switched on and off by turning the current on and off, so the crane can pick up metal (field on) and release it (field off) exactly when needed, oe **B1**

(c) the strength of an electromagnet can also be changed by changing the current, giving more control than a fixed-strength permanent magnet, oe **B1**

(c) Answer: Because the electromagnet's field can be switched on and off (and its strength changed) by controlling the current, allowing scrap metal to be picked up and then released on demand.

Question 7

(a) it reverses the direction of the current in the coil every half turn (every 180 degrees), oe **B1**

(a) this reverses the direction of the force on each side of the coil at the right moment, so the coil keeps rotating in the same direction, oe **B1**

(a) Answer: It reverses the current in the coil every half turn, which reverses the force on each side at the right moment so the coil keeps turning the same way.

(b) the coil carries a current and is in a magnetic field, so each side of the coil experiences a force (the motor effect), oe **B1**

(b) the current flows in opposite directions along the two sides of the coil (up one side, down the other), oe **B1**

(b) by Fleming's left-hand rule, the forces on the two sides act in opposite directions, forming a turning effect (a couple) that rotates the coil, oe **B1**

(b) Answer: Each side of the current-carrying coil is in a magnetic field and experiences a force; because the current flows in opposite directions along the two sides, the forces are in opposite directions, creating a turning effect that rotates the coil.

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Question 8

(a) into the page **B1**

(a) Answer: Into the page.

(b) the force now acts out of the page (it reverses direction), ft from (a) if (a) is consistent **B1**

(b) because reversing the current reverses one of the two quantities used in Fleming's left-hand rule, which reverses the resultant direction of the force, oe **B1**

(b) Answer: The force reverses to act out of the page, because reversing the current reverses the direction given by Fleming's left-hand rule.

Question 9

computes change in flux per turn: 4.2e-4 - 1.2e-4 = 3.0e-4 Wb **M1**

substitutes into emf = N x delta φ / t: emf = 250 x 3.0e-4 / 0.20 **M1**

0.375 V cao **A1**

Answer: 0.375 V

Question 10

(a) $P = 10^2 \times 5.0$, oe **M1**

(a) 500 W, cao **A1**

(a) Answer: 500 W

(b) $P = 100^2 \times 5.0$, oe **M1**

(b) 50000 W (50 kW), cao **A1**

(b) Answer: 50000 W (50 kW)

(c) increasing the current in a cable greatly increases the power wasted as heat, because power loss is proportional to current squared ($P = I^2 R$), oe **B1**

(c) the calculations show that increasing the current by a factor of 10 (from 10 A to 100 A) increases the power lost as heat by a factor of 100 (from 500 W to 50000 W), ft from (a) and (b) **B1**

(c) transmitting power at a high voltage keeps the current low for the same power delivered, which minimises the power wasted as heat in the cables, making transmission more efficient, oe **B1**

(c) Answer: Because power loss is proportional to current squared, a small increase in current causes a much larger increase in power wasted as heat (as shown by the calculations); transmitting at high voltage keeps the current, and so the heat loss, low.

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